PATENT SPECIFICATION

NO DRAWINGS

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1,121,875

1,121,875

Date of filing Complete Specification: 11 Oct., 1966.

Application Date: 12 Oct., 1965. No. 43252/65.

Complete Specification Published: 31 July, 1968.

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Index at acceptance: —C4 VX

Int. Cl.:—B 24 d 1/00

COMPLETE SPECIFICATION

Abrasive Implements

We, THE BRITISH PERICLASE COMPANY LIMITED, a British Company, of Hartlepool, County Durham, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of abrasive implements, for example, wheels, cylinders or other shapes which may be used for cutting or grinding and for removing surface defects from a wide range of materials. Such abrasive implements are widely used for these purposes in industry.

Conventionally, grinding wheels are produced from a mixture of abrasive grit and a bonding material. The mixture is formed into the desired shape and then cured by the application of heat to develop adequate strength in the bonding material. The processes used are widely known and grinding wheels and other shapes may be produced in a wide range of sizes.

The abrasive grit used in the mixture may be one of a range of very hard materials and is usually size graded to quite close limits in order to produce wheels of widely differing but predictable performance. The proportion of abrasive grit to bonding material may also be varied according to the application. Materials commonly used as abrasive grit are fused alumina, silicon carbide and, for certain special cases, diamond. All these materials are expensive to produce in grit form due to the high raw material costs (e.g. diamond), the high costs of the fusion process (alumina and silicon carbide) and the expense of maintaining equipment for crushing and grading such very hard materials. Since the fusion process commonly used gives rise to fused pieces of very large section (e.g. fused alumina blocks weighing perhaps 5 tons), the process of size reduction is necessarily a very expensive one.

The present invention does not utilise such expensive abrasive grit and makes use of the property of extreme hardness which may be achieved in materials produced as a result of the devitrification (crystallisation) of a glass containing an effective amount of a nucleating agent. Such a glass may be based on a metallurgical slag and have a composition:—

SiO_2	45 to 65%
CaO	15 to 45%
Al_2O_3	5 to 30%
MgO	up to 10%

In at least one known example, the crystallised product is known as Slagceram. This material and the method of making it are fully described and claimed in British Patent Specification No. 986,289 in the name of the British Iron and Steel Research Association, to which reference is directed.

According to one aspect of the invention there is provided a method of making an abrasive implement which method comprises granulating a glass which contains an effective amount of a nucleating agent to cause the devitrification of the glass, devitrifying the granules, mixing them, optionally after further size reduction, with a bonding agent, and shaping and curing the mixture, to provide the abrasive implement.

The glass or metallurgical slag is prepared in a molten condition with the addition of any materials such as SiO_2 needed to bring it into the appropriate compositional range and the nucleating agent. This may then be granulated, either by quenching a hot stream of the molten glass so that the thermal shock to the glass is such as to break it into separate granules or by passing a cooled ribbon or larger cooled pieces of glass

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through conventional crushing equipment. The granulated material may then be screened in order to remove the smaller particles, say those less than $\frac{1}{4}$", and these may then be returned to the melting unit. Another alternative is to form the glass into small marbles, for example, approximately $\frac{1}{2}$" diameter. This is a ready and convenient form in which to handle the glass through the devitrifying stage and eliminates the need to screen off smaller particles.

The remaining coarser particles which may be in the size range $\frac{1}{4}$" to $\frac{1}{2}$" or any other convenient size appropriate to the heating equipment to be later described, are then heated in such a way, as to enable, first nucleation and secondly devitrification (crystallisation) of the glass to occur, thus producing a micro-crystalline material. Thus the glass granules may be devitrified by heating at substantially 720° C. and thereafter at substantially 950° C. before slowly cooling the glass.

The heat treatment may be carried out in any appropriate heating unit such as a rotary kiln or a fluidised bed or a sinter-strand which will enable the individual granules to be heat treated and yet remain either as discrete granules or be only very lightly attached to neighbouring granules.

Instead of separating the granules before devitrification, the hot stream of the glass may be quenched in such a way as to produce a continuous crack network although maintaining the glass in a substantially coherent form so that it may be passed to the heat treatment furnace in a readily handled form.

Alternatively the glass may be formed as substantially flat product, toughened in the normal way and then subjected to surface damage so as to shatter the product into small pieces while supported underneath. In both cases, the heat treatment furnace may be any furnace which can handle a flat product.

After heat treatment, the points of weakness in the glass where it was cracked are still present and allow it to be readily broken down into a range of particle sizes.

The resulting very hard granules may be further crushed to the required particle size, mixed with a bonding agent, and the mixture shaped and cured so as to produce the abrasive implement.

According to an alternative aspect of the invention there is provided a method of making an abrasive implement which method comprises granulating a glass, which contains an effective amount of a nucleating agent to cause the devitrification of the glass to provide particles of the size required in the implement, mixing the particles with a bonding agent and shaping and heating the mixture to cure the bonding agent and devitrifying the glass particles so as to provide the abrasive implement.

In this second aspect, the granulation step is continued to produce discrete particles of the glass of the sizes required in the abrasive implement. Thus, the invention makes extensive size reduction of the abrasive material unnecessary, by performing the size reduction on the comparatively soft, vitreous material; while the second aspect of the invention completely eliminates all size reduction of the abrasive material.

The invention also includes abrasive implements, for example, grinding wheels, when made by the method described above.

Following is a specific example of methods of making abrasive implements in accordance with this invention.

A blast furnace slag of the following chemical analysis was melted with the addition of 30% by weight of silica sand and 3% by weight of chromite.

Blast Furnace Slag Analysis

	Wt.%
SiO_2	32.5
Al_2O_3	17.4
CaO	36.5
MgO	7.5
Fe_2O_3	1.4
MnO	1.5
TiO_2	0.8
Alkalis	1.5

The melt was maintained in a large pot in a furnace at 1450—1500° C. until it was substantially bubble free. It was then poured into moulds so as to form plates approximately 9" square by $\frac{1}{2}$" thick. These were quench cooled so as to break up the glass into particles graded from approximately $\frac{1}{2}$" B.S. mesh downwards. From this point two alternative routes were followed.

Alternative 1

The glass particles were sieved so as to remove most of the particles smaller than $\frac{1}{4}$". The remaining particles were heated in a furnace at 720° C. for 3 hours and then at 950° C. for 3 hours before slow cooling. The resulting devitrified granules were then crushed, without appreciable difficulty, to pass 6 B.S. mesh. From the crushed material, the particles passing 10, but retained on 72 B.S. mesh were screened off and bonded with about 20% of a bond consisting of 30% ball clay and 70% glass grit with sufficient tempering water to give plasticity. The mix was then formed under pressure into the shape of a grinding wheel and then baked at a temperature of 1000° C. After cooling it had formed a strong, well bonded abrasive wheel.

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Alternative 2

The fractured glass particles were further reduced by crushing to pass B.S.6 mesh. From the crushed material, the particles passing 10 and retained on 72 B.S. mesh were sieved as before and bonded with a bonding mixture similar to that used in Alternative 1. After mixing and pressing, as before described, the article was heat treated at 720° C. for 3 hours, at 950° C. for 3 hours and at 1000° C. for 1 hour. After slow cooling the glass particles were found to have devitrified in situ and the whole formed a strong, well bonded abrasive wheel.

It will be understood that the particle sizes used in the examples are not the only ones possible and that many alternative combinations of sizes will be known to those skilled in the art. Similarly, other types and quantities of bonds may be used as long as they can be cured to form a strong bond at temperatures which will not interfere with the devitrification process, and in the case of Alternative 2, which will not be destroyed by the heat treatment given to devitrify the graded particles.

WHAT WE CLAIM IS:—

1. A method of making an abrasive implement which method comprises granulating a glass which contains an effective amount of a nucleating agent to cause the devitrification of the glass, devitrifying the granules, mixing them with a bonding agent, and shaping and curing the mixture to provide the abrasive implement.

2. A method of making an abrasive implement which method comprises granulating a glass which contains an effective amount of a nucleating agent to cause the devitrification of the glass, devitrifying the granules, mixing them after further size reduction with a bonding agent and shaping and curing the mixture to provide the abrasive implement.

3. A method as claimed in claim 1 or claim 2 wherein the glass is derived from a metallurgical slag and comprises from 45 to 65% SiO_2, from 15 to 45% CaO, from 5 to 30% Al_2O_3, up to 10% MgO and an effective amount of a nucleating agent to cause the devitrification of the glass, the stated percentages being percentages by weight.

4. A method as claimed in any one of the preceding claims wherein the glass granules are devitrified by heating at substantially 720° C. and thereafter at substantially 950° C. before slowly cooling the glass.

5. A method as claimed in any one of the preceding claims wherein the glass is granulated before devitrification by quenching a hot stream of the molten glass so that the thermal shock to the glass is such as to break the glass into separate granules.

6. A method as claimed in any one of claims 1 to 4 wherein the glass is granulated, before devitrification by crushing a cooled ribbon of glass or larger cooled pieces of the glass.

7. A method as claimed in any one of claims 1 to 4 wherein the glass is granulated before devitrification by forming it into small marbles.

8. A method as claimed in any one of claims 1 to 4 wherein a hot stream of the glass is quenched so as to produce a continuous crack network in the glass and wherein the quenched glass is maintained in a substantially coherent form for devitrification.

9. A method as claimed in any one of claims 1 to 4 wherein the glass is formed as a substantially flat product, is toughened in the conventional manner and is thereafter subjected to surface damage so as to shatter the product into small pieces whilst maintaining the product supported from underneath, the product being thereafter devitrified in this form.

10. A modification of the method of making an abrasive implement as claimed in any one of claims 1 to 6 comprising granulating a glass, which can be devitrified by heating, to provide particles of the size required of the abrasive grit in the implement, mixing the particles with a bonding agent and shaping and heating the mixture to cure the bonding agent and devitrifying the glass particles so as to provide the abrasive implement.

11. A method of making an abrasive implement as claimed in claim 1 or claim 2 substantially as hereinbefore described in the specific example.

12. A method of making an abrasive implement as claimed in claim 10 substantially as hereinbefore described in the specific example.

13. An abrasive implement whenever made by the method claimed in any one of the preceding claims.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1968.
Published by the Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

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